STABILIZING METHOD OF SOIL IN SHOOTING FIELD

Patent number:	JP2000189943
Publication date:	2000-07-11
Inventor:	KEITH E FORESTER
Applicant:	KEITH E FORESTER
Classification:	
- international:	B09C1/02; B09C1/08
- european:	
Application number:	JP20000000127 20000104
Priority number(s):	

BEST AVAILABLE COPY

Abstract of **JP2000189943**

PROBLEM TO BE SOLVED: To decrease elution of lead from berm soil by seeding a dry lead stabilizer in the berm soil so that when lead bullets are fired into the berm soil, the bullets are mixed with the lead stabilizer and then stabilized as the apatite or compd. of the lead stabilizer.

SOLUTION: At least one kind of lead stabilizer containing perphosphates, phosphate fertilizer, phosphoric acid or the like in an effective amt. to decrease elution of lead from soil or material to an allowable level is brought into contact with berm soil or material. For example, using a granulated phosphate fertilizer such as triple superphosphate realizes a certain amt. of water-soluble phosphate in contact with the berm soil immediately after the fertilizer is applied on the soil surface, contact in a higher level with the soil, and stabilization of lead when lead is released from the soil or the matrix of lead bullets by rain water. The dry lead stabilizer is seeded in the berm soil so that lead can be stabilized as an apatite or compd. of the lead stabilizer.

Data supplied from the ***esp@cenet*** database - Worldwide

AM

(19)日本国特許庁（ＪＰ）　(12) **公開特許公報**（Ａ）　(11)特許出願公開番号
特開2000－189943
(P2000－189943A)
(43)公開日　平成12年7月11日(2000.7.11)

(51)Int.Cl.⁷	識別記号	F I	テーマコード*(参考)
B09C　1/02 1/08		B09B　3/00	304K

審査請求　未請求　請求項の数13　ＯＬ　外国語出願　（全 18 頁）

(21)出願番号	特願2000－127(P2000－127)
(22)出願日	平成12年1月4日(2000.1.4)
(31)優先権主張番号	０９／２２２９８６
(32)優先日	平成10年12月29日(1998.12.29)
(33)優先権主張国	米国（ＵＳ）

(71)出願人　599008584
キース　イー．フォレスター
アメリカ合衆国　ニュー　ハンプシャー
03843－2008　ハンプトン，ピー．オー．
ボックス　2008
(72)発明者　キース　イー．フォレスター
アメリカ合衆国　ニュー　ハンプシャー
03843－2008　ハンプトン，ピー．オー．
ボックス　2008
(74)代理人　100095832
弁理士　細田　芳徳

(54)【発明の名称】　射撃場の土壌の安定化方法

(57)【要約】

【課題】拳銃およびライフル銃の射撃場の土壌からの鉛の溶脱を低減させる方法を提供すること。

【解決手段】射的の背後にある弾丸を停止させるバームとして使用される土壌または材料を鉛安定化剤種と接触させることを含む方法。

ADA

【特許請求の範囲】

【請求項１】　連邦公報５５巻１２６号２６９８５－２６９９８頁（１９９０年６月２９日）で発表されている生成した処理土について行なわれるＥＰＡ・ＴＣＬＰテストで測定したときに土壌または材料からの鉛の溶脱を鉛５．０ｐｐｍ以下のレベルに低減させるのに有効な量の少なくとも１つの過リン酸塩、リン酸肥料、リン酸、リン鉱石、リン酸塩と錯化剤、石灰、または石灰とケイ酸塩と、ライフル銃、拳銃または法定の射撃場での鉛弾丸の捕集装置およびバックストップとしての使用に好適な粒状性を維持する、射撃場の土壌または材料とを接触させることを含む射撃場の土壌または材料における鉛の安定化方法。

【請求項２】　リン酸塩およびリン酸塩と錯化剤が、三重過リン酸石灰、グリーンリン酸、リン酸肥料、リン鉱石、共生成物およびそれらの塩からなる群より選ばれたものである請求項１記載の方法。

【請求項３】　リン酸の塩が、アルカリ金属塩である請求項２記載の方法。

【請求項４】　リン酸塩が、リン酸三ナトリウム塩、リン酸水素二ナトリウム塩、リン酸二水素ナトリウム塩、リン酸三カリウム塩、リン酸水素二カリウム塩、リン酸二水素カリウム塩、リン酸三リチウム塩、リン酸水素二リチウム塩、リン酸二水素リチウム塩またはそれらの混合物である請求項２記載の方法。

【請求項５】　リン酸塩と鉄またはアルミニウムとしての錯化剤とを、三重過リン酸石灰、湿式法リン酸、グリーンリン酸、琥珀色リン酸またはアルミニウムの仕上げ加工で得られた共生成物を含む生成物として供給する請求項２記載の方法。

【請求項６】　射撃場の土壌を、該土壌の総重量の０．０１重量％～約１５重量％に等しい量の少なくとも１つのリン酸塩、リン酸肥料、三重過リン酸石灰、リン酸塩と錯化剤、石灰、石灰とケイ酸塩と接触させる請求項１記載の方法。

【請求項７】　射撃場の全土壌の約１．０重量％～約１５重量％に等しい量の少なくとも１つのリン酸塩、リン酸肥料、過リン酸塩、リン鉱石、リン酸塩と錯化剤、石灰、石灰とケイ酸塩と該土壌とを接触させる請求項１記載の方法。

【請求項８】　射撃場の全土壌の約１～約５重量％に等しい量の少なくとも１つのリン酸塩、リン酸塩と錯化剤、石灰、石灰とケイ酸塩と該土壌とを接触させる請求項１記載の方法。

【請求項９】　耕うん、混和、混合または他の土壌の混合形式で鉛で汚染されたあるいは汚染されていない射撃場の土壌に安定化剤を添加することによって前記接触を行なう請求項１記載の方法。

【請求項１０】　接触工程が、全土壌の約１重量％～約１５重量％に等しい量の前記少なくとも１つのリン酸塩、リン酸塩と錯化剤、石灰、石灰とケイ酸塩と射撃場の土壌とを接触させることを含む請求項１記載の方法。

【請求項１１】　接触工程が、乾燥状態の少なくとも１つのリン酸塩、リン鉱石、リン酸肥料、過リン酸塩、リン酸塩と錯化剤、石灰、石灰とケイ酸塩を前記土壌に適用して処理された土壌を生成し、直接土壌中に湿潤剤を使用するか、または射撃されたその位置で前記土壌を水と接触させることにより、処理された土壌中の溶解性の鉛種を不溶化させ、さらにリン酸塩、リン酸塩と錯化剤、石灰、石灰とケイ酸塩を可溶化させ、可溶性の鉛種を不溶化させることを含む請求項１記載の方法。

【請求項１２】　連邦公報５５巻１２６号２６９８５－２６９９８頁（１９９０年６月２９日）で発表されている生成した処理土について行なわれるＥＰＡ・ＴＣＬＰテストおよび他の要求される溶脱試験で測定したときに土壌または材料からの鉛の溶脱を許容される溶脱レベルに低減させるのに有効な量の、過リン酸塩、リン酸肥料、リン酸、リン鉱石、リン酸塩と錯化剤、石灰、または石灰とケイ酸塩を含む少なくとも１つの鉛安定化剤と、ライフル銃、拳銃または法定の射撃場での鉛弾丸の捕集装置およびバックストップとしての使用に好適な自由流れの粒状性を維持する、射撃場の土壌または材料とを接触させることを含む射撃場の土壌または材料における鉛の安定化方法。

【請求項１３】　存在している鉛を安定化させ、かつ射撃場の土壌の中に発射された新たな鉛弾丸を引き続いて安定化させるための余剰の安定化剤を与える方法で安定化剤を種として土壌に添加する請求項１２記載の方法。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、ライフル銃の射撃場、拳銃および散弾の土壌のバームからの鉛の溶脱を低減する方法に関する。

【０００２】

【従来の技術】自然環境の中に鉛が浸出することは、多年にわたって衛生官や水供給業者の大きな関心事である。取締者および専門家は、地下水や地表水に直接鉛が浸出することに関心をもつほか、有機物の腐敗による酸性の浸出条件を生じる表面に覆いのないごみ処理地からの鉛の間接的な浸出、したがって高レベルの鉛が浸出する可能性にも関心をもっている。水およびごみ処理地の双方の浸出物が生まれる条件から鉛が浸出する懸念に対して、議会からの監督下にあるＵＳＥＰＡは、鉛を含む廃棄物の試験、管理および廃棄に対する規制を作成した。資源保存回復法(Resource Conservation and Recovery Act)（ＲＣＲＡ）および総合環境応答、補償および責任法（Comprehensive Environmental Response, Compensation, andLiability Act）（ＣＥＲＣＬＡ－別名スーパーファンド(Superfund)）の下での規制は、広範囲で複雑であり、鉛を含む重金属を必要とする工業および慣

行に大きな影響を与えている。ＲＣＲＡの下では、毒特性溶脱法(Toxicity Characteristic Leaching Procedure)（ＴＣＬＰ）で５ｐｐｍに合格しなかったなら、鉛を含む廃棄物が危険であるとみなされ、危険廃棄物処理地または処理、貯蔵および処理施設（ＴＳＤＦ）で処分することが要求されるであろう。これらの選択肢は、非常に高価であり、廃棄物トンあたり通常２００．００ドルである。ＣＥＲＣＬＡの下では、州が清掃基準値を定める柔軟性を有するので、取締者は、ほとんどのレベルにおいて鉛廃棄物の処理を規制したり、要求することができる。その結果、Ｐｂを含む廃棄物を生産すると、非常に高価となる。同様の規制条件が日本、スイスなどの規制において存在している。今日まで、射撃場の土壌は、近接した射撃場の敷地における土壌の安定化または処分を要求するＣＥＲＣＬＡの方策でのみ規制とされている。その土壌は、一般に５．０ｐｐｍのＴＣＬＰ規格に合格せず、したがって独特の有害廃棄物である。これらの鉛で汚染された土壌を管理するのに使用される一般的な方法は復古的であり、即ち、それらの方法では、土壌が汚染された後に、つまり結果的には危険性が存在した後に、鉛が処理される。鉛の土壌を処理するのに使用される薬品には、リン酸塩、ケイ酸塩、セメントおよび硫化物が含まれる。しかしながら、廃棄物が生成する前に鉛を含む材料または廃棄物にリン酸塩と錯化剤を添加することを示唆するフォレスター(Forrester)5,722,928を除けば、該方法は設計上復古的である。この方法の下でも、フォレスターは、既に鉛を含む廃棄物について対処している。

【０００３】

【発明が解決しようとする課題】本発明は、鉛が含まれる前に射撃場の土壌に播種する方法を有し、したがってＴＣＬＰレベルでＰｂを処理することの問題が現れず、また鉛の曝露が生じたり存在した後にのみ鉛廃棄物を管理する場合と比較して、接触時にただちに鉛が安定化される。

【０００４】

【課題を解決するための手段】本発明は、ライフル銃の射撃場、拳銃および散弾の土壌のバームからの鉛の溶脱を低減する方法に関する。該方法には、バームに発射したときに鉛弾丸が鉛安定化剤と混ざり合い、引き続いて鉛安定化剤のリン灰石または化合物として安定化されるように、乾燥鉛安定化剤をバームの土壌に播種することが含まれる。

【０００５】本発明は、土壌または材料のバーム中で汚染物質として最初に生じたときに、ただちに鉛の溶脱が低減されるという利点を有する。このことにより、土壌のバームがＴＣＬＰレベル未満となり、したがってＲＣＲＡ有害廃棄物規制から除外されることになる。その場所での迅速な安定化により、確実に、Ｐｂの溶脱が制御され、元素または鉛酸化物のような弾丸の鉛の形態よりもいちじるしく移動性および毒性が低い、ケイ酸塩、水酸化物、ヒドロキシアパタイトＰｂ鉱物と接触するとただちに緑鉛鉱、リン酸鉛、安定な化合物などの水不溶性の鉛化合物が生じることにより、環境および人間に曝される危険性が低減される。

【０００６】鉛の安定化種によって、バームの弾丸の吸着性、密度、水透過性、外観、斜面安定性、逃散性、流出係数、粒径分布、成形性または作業性が変わらず、したがって、開放された環境での弾丸の停止および回収体としてのバームの効果が維持されていることが保証されるであろう。乾燥安定化剤種の特性は、通常の使用において、バームの土壌が余剰の安定化能を保持していることを保証するうえで不可欠である。

【０００７】

【発明の実施の形態】本明細書において、材料または土壌の安定化は、弾丸が目標訓練または競技に使用される、ライフル銃、拳銃、散弾銃または軍隊の法定の射撃場において、鉛弾丸の管理または制御に使用される砲床、トラップ、バーム、停止材または障壁からの鉛の溶脱を低減させることとして定義される。溶脱の低減は、その材料または廃棄物について、好適なまたは取締り上必要とされる溶脱試験を行なうことによって測定することができる。

【０００８】発射されるまたは既に土壌に発射された弾丸における鉛は、元素状態および／または陽イオン状態であってもよい。もっとも一般的な鉛の状態は、土壌および／または他の材料と高速で接触したときに、土壌表面上で残存する弾丸スラッジないしスラッジの微粒子状の元素である。弾丸に曝される土壌には、１００，０００ｐｐｍ程度の組成的な鉛および３００ｐｐｍのＴＣＬＰで溶脱しうる鉛が含まれていてもよい。鉛弾丸が曝された土壌における溶脱しうる鉛は、一般に、ＴＣＬＰ（１）で５０〜１００ｐｐｍであり、カリフォルニア・ソルブル・スレシュホールド・リミット・コンセントレーション(California Soluble ThresholdLimit Concentration)（ＳＴＬＣ）で２００ｐｐｍであり、水カラムおよび水抽出試験によって全体として溶解性があり、１．０ミクロンの懸濁されたコロイド状鉛で０．５〜５．０ｐｐｍである。

【０００９】本明細書で定義される溶脱試験条件には、希酢酸溶脱（ＴＣＬＰ）、クエン酸緩衝液溶脱（ＳＴＬＣ）、蒸留水または炭酸水溶脱（日本およびスイスならびにＳＷ−９２４）の際に材料または土壌が供される条件が含まれる。好適な酢酸溶脱試験には、ＵＳＥＰＡ　ＳＷ−８４６　マニュアルに記載されている毒特性溶脱法(Toxicity Characteristic Leaching Procedure)（ＴＣＬＰ）および現在、カナダで使用されている抽出法毒性試験（イクストラクション・プロセデュア・トキシティ・テスト）(Extraction Procedure Toxicity Test)（ＥＰ　Ｔｏｘ）が含まれる。簡単にいえば、ＴＣＬ

Ｐ試験において、廃棄物１００ｇを希酢酸緩衝液２０００ｍｌで１８時間攪拌する。抽出溶液は、氷酢酸５．７ｍｌおよび１．０規定の水酸化ナトリウム６４．３ｍｌ、それに１０００ｍｌに希釈する試薬用水から構成される。

【００１０】好適な水溶出試験には、ｐＨが５．８～６．３に保持された水５００ｍｌ中で複合土壌試料５０ｇを攪拌し、次いで遠心分離し、分析前に０．４５ミクロンで濾過する日本の溶出試験が含まれる。もう１つの好適なCO_2が飽和した蒸留水法は、２つの２０００ｍｌの連続的な水浴に１ｃｍ^{3}あたり固めた廃棄物１００ｇを用いるスイスプロトコル(Swiss protocol)である。重金属および塩の濃度を各浴で測定し、スイス基準(Swiss criteria)と比較する前に合体させて平均する。

【００１１】好適なクエン酸溶出試験には、カリフォルニア・ヘルス・アンド・セーフティ・コード(California Health and Safety Code) の「環境保健(EnvironmentalHealth)」タイトル２２，セクション６６７００に記載されているカリフォルニア・ウェイスト・イクストラクション・テスト(California Waste Extraction test)（ＷＥＴ）が含まれる。簡単にいえば、ＷＥＴ試験において、クエン酸ナトリウム溶液５００ｇを入れた１０００ｍｌ容のタンブラー中で廃棄物５０ｇを４８時間かき混ぜる。次に、該廃棄物に含まれる溶脱しうる鉛をクエン酸陰イオンで錯化させ、クエン酸鉛を生成させる。次に、タンブラーから分取した１００ｍｌを４５ミクロンのガラスビーズフィルターを通して濾過した後、溶脱した鉛の濃度を誘導結合プラズマ（ＩＣＰ）で分析する。鉛が≧５ｐｐｍのＷＥＴの結果では、カリフォルニア州においては、該射撃場の土壌が有害物となるであろう。

【００１２】１つの方法においては、少なくともわずかに水溶性、希酢酸に可溶および／またはクエン酸に可溶である小球化された(prilled) 安定化剤と射撃場の土壌を接触させる。要求される溶脱試験規格とともに、その現地条件に応じた好ましい選択をすれば、種々の安定化剤を選択することにより、薬品の配合を選択する際に設計技術者に柔軟性が与えられる。リン酸モノアンモニウム（ＭＡＰ）、リン酸ジアンモニウム（ＤＡＰ）、過リン酸石灰（ＳＳＰ）、三重過リン酸石灰（ＴＳＰ）などの小球化されたリン酸肥料を用いることにより、一例ではあるが、表面曝露の際にただちに射撃場の土壌と接触するある程度の量の水溶性リン酸塩と、より高いレベルの土壌との接触と、雨水によって土壌および鉛弾丸のマトリックスから溶脱した際の鉛の安定化が与えられる。所望の初期の乾燥粒子の接触および雨水の浸出による接触に応じて、そのＭＡＰ、ＤＡＰ、ＳＳＰおよびＴＳＰの大きさ、投与量の割合、土壌への適用、リン酸塩安定化剤の含量、表面被覆および配置方法を設計することができる。乾燥表面の接触により、あるいは水で生じるイオンを介して鉛が安定化剤と接触するようになったとき、特に溶脱試験の条件下で、本来土壌中または弾丸中にある鉛よりも溶解しがたい低水溶性化合物、一般的にはミネラルリン酸塩または沈澱物を生成する。例えば、ミネラルアパタイトリン酸鉛$Ca_4(Pb)(PO_4)_3OH$、リン酸鉛$Pb_3(PO_4)_2$、ケイ酸鉛$Pb_2(SiO_3)$および硫化鉛PbSは、それぞれ、鉛の存在下で射撃場の土壌に沈澱剤種を添加することにより、生成させることができる。

【００１３】好適な鉛沈澱剤および安定化剤の例には、リン酸塩；リン酸肥料ＭＡＰ、ＤＡＰ、ＳＳＰ、ＴＳＰ；リン鉱石、粉砕されたリン鉱石、正リン酸カルシウム、小球化されたリン酸肥料、ドロマイト質石灰、中礫状石灰、岩状石灰、硫化物、メタスルフィド、炭酸塩、酸化マグネシウム、ケイ酸塩、メタケイ酸ナトリウム、セメント、ポルトランドセメント、リン酸塩、および鉛錯化剤の組合せおよび上記の組合せ、リン酸、グリーンリン酸、琥珀色リン酸、共生成物溶液、正リン酸、次リン酸、メタリン酸、ピロリン酸、リン酸水素二ナトリウム、リン酸三ナトリウムおよびそれらの組合せが含まれる。

【００１４】本発明の方法における鉛安定化剤の使用量は、土壌における鉛含量、射撃場の土壌に対して潜在的に残存させるのに必要な鉛安定化剤、所望の鉛低減能力および現地の環境制御目標を含む種々の要因に依存する。鉛を適切に固定化させる、射撃場の土壌に添加される鉛安定化剤の量は、緩衝能力とともに存在していてもよい、射撃場の土壌および／または他の固体残渣のアルカリ度、初期から存在している鉛フラグメントの量などの変数にも依存するであろう。射撃場の土壌の約１重量％～約２重量％に等しい量の小球化された三重過リン酸石灰、錯化剤を有するリン酸塩、ケイ酸塩などの一定の安定化剤は、初期のＴＣＬＰの安定化および少なくとも５年間播種された射撃場その場での安定化のための残存リン酸塩の負荷に十分であることが判明した。そのことについて、約２重量％に等しい量のリン酸塩は、非常に十分に作用するので、湿潤土壌の約０．１重量％～約２重量％に等しい量のリン酸塩、錯化剤を有するリン酸塩、ケイ酸塩または他の安定化剤源は十分であると考えられる。しかしながら、前述のことは、５重量％よりも多い量でも作用することを示しているものの、よりコストがかかることから、必要とされる場合には、より多量の安定化剤種を使用することまでを排除することを意図するのではない。

【００１５】以下の実施例は、本発明をただ単に例証するものであり、本発明を限定することを意図するものではない。

【００１６】

【実施例】本実施例において、小球化された三重過リン酸石灰（ＴＳＰ）、粒子状リン鉱石（ＲＯＣＫ）、グリーンリン酸（ＰＯ４）、岩状石灰（ＣＡＯ）、岩状石灰とケイ酸ナトリウム（ＣＡＯ／ＮＳ）および共生成物

（ＣＯＰ）を含む安定化剤の種剤の量を変えて射撃場の土壌を処理し、露天で種々の日数雨水溶脱を行なった後に再試験した。次に、播種した射撃場の土壌の試料を、本明細書中に参照までに含められている、連邦公報５５巻１２６号２６９８５～２６９９８頁（１９９年６月２９日）に発表されているＴＣＬＰ法に従って抽出し、ＴＣＬＰ試験において、ＴＣＬＰ抽出液の代わりに脱イオン水を置換して水抽出を行なった。この試験方法は、４０Ｃ．Ｆ．Ｒ．２６０（補遺(Appendix)２）およびＥＰＡ　ＳＷ８４６第３版にも述べられている。残留している溶脱物は、ＩＣＰによる分析の前に消化させた。その後、試薬を単純に手で攪拌して添加した。

【００１７】

表　１

種類－日数	薬品％	ＴＣＬＰ　Pb(ppm)	水Pb(ppm)
土壌－０	ベースライン	143.6	1.4
土壌－０	１ＴＳＰ	15.4	ＮＤ
土壌－０	２ＴＳＰ	〈0.05(ND)	ＮＤ
土壌－０	２ＰＯ４	ＮＤ	ＮＤ
土壌－０	２ＣＯＰ	0.32	ＮＤ
土壌－０	２ＲＯＣＫ	1.65	ＮＤ
土壌－０	３ＣＡＯ	0.20	1.3
土壌－０	２ＣＡＯ／１ＮＳ	ＮＤ	ＮＤ
土壌－３６５	ベースライン	157	0.94
土壌－３６５	１ＴＳＰ	4.3	ＮＤ
土壌－３６５	２ＴＳＰ	ＮＤ	ＮＤ
土壌－３６５	２ＰＯ４	0.83	ＮＤ
土壌－３６５	２ＣＯＰ	2.4	ＮＤ
土壌－３６５	２ＲＯＣＫ	1.20	ＮＤ
土壌－３６５	３ＣＡＯ	4.2	3.2
土壌－３６５	２ＣＡＯ／１ＮＳ	ＮＤ	ＮＤ

【００１８】上述の表１における結果により、種々の程度の安定化種を土壌中に与え、したがって鉛に曝されているときに鉛の溶脱を抑制し、ＴＣＬＰ溶脱水準によって危険廃棄物として規制されるのを回避する射撃場の土壌をつくりだすことができるとともに、射撃場の土壌において溶脱しうるＴＣＬＰおよび水溶性鉛を固定化させる本発明の方法の操作性が容易に確証された。表１に示されているように、鉛を安定化させる際に、三重過リン酸石灰、リン酸塩と錯化剤、石灰、石灰とケイ酸塩の効力を与えれば、射撃場の土壌の１重量％未満に等しい量の、三重過リン酸石灰、リン酸塩と錯化剤、石灰、石灰とケイ酸塩などの安定化剤は、射撃場の弾丸に由来する鉛を固定化させるのに効果的であるものと思われる。また、表１の結果から、三重過リン酸石灰などのある種の安定化させる種は、短期間ないし長期間溶脱物が生成するのを抑制する際に、より効果的であることが明らかである。ある安定化剤は、石灰などのより溶解性が大きい薬品よりも水溶性となる親和性が小さく、したがってより長い期間効果的に鉛の抑制を維持する。また、ある種の薬品は、射撃場の土壌のｐＨを向上させる潜在的能力を有しており、したがってベースラインのデータと比較して、鉛の水溶脱能力を向上させる。これらの適用においては、ＴＣＬＰの制御によって雨水による鉛の溶脱が増大することが引き起こされないようにするために注意しなければならない。遠く離れた石灰領域などのように鉛の水溶脱が殆ど関係しないところでは、すべての前例の安定化剤が好適であろう。溶脱物が地下水や地表水と接触するかもしれないような場所では、薬品を三重過リン酸石灰およびリン鉱石に限定すべきであり、そのようにすることによって雨水による短期間ないし長期間の鉛の溶脱能が制限される。

【００１９】上記のことから、本発明の概念から逸脱することなく、当該技術において経験を有する者によって本明細書で上述した方法および組成について数多くの他の変形および変更を行なうことができることは明らかであろう。したがって、本明細書において上記で述べられている方法および組成は、例証のみであり、本発明の範囲において限定することを意図するものではないことは明らかに理解されるであろう。

【００２０】

【発明の効果】鉛安定化剤を土壌または材料に播種することにより、既にバームにある鉛を安定化させる手段が提供され、それにより、鉛安定化剤種と接触するときまたは鉛安定化剤種を介して溶脱する雨水と接触するときに、バーム中に将来発射される鉛銃弾、破片または鉛散弾を安定化させることもできる。この方法により、将来、使用後に射撃場の土壌を除去したり、再処理をする必要性が除去される。

【外国語明細書】

1. Title of Invention

RANGE SOIL STABILIZATION METHOD

2. Claims

1. A method of stabilizing lead in a range soil or material comprising contacting said range soil or material with an amount of at least one superphosphate, phosphate fertilizer, phosphoric acid, phosphate rock, phosphate and complexing agents, lime, or lime and silicates that is effective to reduce the leaching of lead from said soil or material to a level no more than 5.0 ppm lead as determined in an EPA TCLP test performed on the resulting treated soil as set forth in the Federal Register, vol. 55, no. 126, pp. 26985-26998 (Jun. 29, 1990) wherein said soil or material maintains its particulate nature suitable for use as a lead projectile collector and backstop at a rifle, handgun or ordinance firing range.

2. The method of claim 1, wherein the phosphate and phosphate and complexing agents, is selected from the group consisting of Triple Superphosphates, green phosphoric acid, phosphate fertilizers, phosphate rock, Coproduct, and salts thereof.

3. The method of claim 2, wherein the salts of phosphoric acid are alkali metal salts.

4. The method of claim 2, wherein the phosphate salt is a trisodium phosphate, disodium hydrogen phosphate, sodium dihydrogen phosphate, tripotassium phosphate, dipotassium hydrogen phosphate, potassium dihydrogen phosphate, trilithium phosphate, dilithium hydrogen phosphate, lithium dihdrogen phosphate or mixtures thereof.

5. The method of claim 2, wherein the phosphate and complexing agent as iron or aluminum are supplied as one product including Triple Superphosphate, wet process phosphoric acids, green phosphoric acid, amber phosphoric acid, or Coproduct produced from finishing aluminum.

6. The method of claim 1, wherein the range soil is contacted with at least one phosphate, phosphate fertilizer, triple superphosphate, phosphate and complexing agents, lime, lime and silicates, in an amount equivalent to 0.01% to about 15% by weight based on the total soil weight.

7. The method of claim 1, wherein the soil is contacted with at least one phosphate, phosphate fertilizer, superphosphate, phosphate rock, phosphate and complexing agent, lime, lime and silicates, in an amount equivalent to about 1.0% to about 15% by weight of total range soil.

8. The method of claim 1, wherein the soil is contacted with at least one phosphate, phosphate and complexing agent, lime, lime and silicates, in an amount equivalent to about 1 to about 5% by weight of total range soil

9. The method of claim 1, when said contacting is performed by addition of lead contaminated or uncontaminated range soil with stabilizing agents through tilling, mixing, blending, or other forms of soil mixing.

10. A method as in claim 1 wherein the contacting step comprises contacting range soil with said at least one phosphate, phosphate and complexing agent, lime, lime and silicates, in an amount equivalent to about 1 wt% to about 15 wt% based on the total soil.

11. A method as in claim 1 wherein the contacting step comprises: applying a dry form of at least one phosphate, phosphate rock, phosphate fertilizer, superphosphate, phosphate and complexing agent, lime, lime and silicates, to said soil to form a treated soil and insolubilizing the soluble lead species in the treated soilue in-line by use of the wetting agent within the soil or in situ in a range site by contacting said soil with water to further solubilize the phosphate, phosphate and complexing agent, lime, lime and silicates, and insolubilize the soluble lead species.

12. A method of stabilizing lead in a range soil or material comprising contacting said range soil or material with an amount of at least one lead stabilizing agent including superphosphate, phosphate fertilizer, phosphoric acid, phosphate rock, phosphate and complexing agents, lime, or lime and silicates that is effective to reduce the leaching of lead from said soil or material to acceptable leaching levels as determined in an EPA TCLP test performed on the resulting treated soil as set forth in the Federal Register, vol. 55, no. 126, pp. 26985-26998 (Jun. 29, 1990) and other leaching tests required wherein said soil or material maintains its free flowing particulate nature suitable for use as a lead projectile collector and backstop at a rifle, handgun or ordinance firing range.

13. The method of claim 12 wherein the stabilizing agent is added as a seed to the soil in a manner to both stabilize existing lead and provide residual stabilizing agent for subsequent stabilization of new lead projectiles fired into the range soil.

3. Detailed Description of Invention

Technical Field to Which the Invention Pertains

The present invention relates to a method for reducing the leaching of lead from rifle range, handgun and shot soil berms.

Prior Art

The leaching of lead into the environment has been a major concern of health officials and water supply professionals for many years. In addition to concern over direct leaching of lead into ground waters and surface waters, regulators and professionals have also been concerned with indirect leaching of lead from unlined landfills which generate acidic leaching conditions due to decay of organic matter and thus high levels of lead leaching potential. In response to the concern of lead leaching from both water and landfill leachate borne conditions, the USEPA under direction from Congress, prepared regulations for testing, managing and disposing of lead bearing wastes. The regulations under the Resource Conservation and Recovery Act (RCRA) and Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA - aka Superfund) are extensive, complex, and have great impact on industry and practices involving heavy metals including lead. Under RCRA, lead bearing wastes may be considered hazardous if failing the Toxicity Characteristic Leaching Procedure (TCLP) at 5.0 ppm, and thus required to be disposed at a hazardous waste landfill or treatment, storage and disposal facility (TSDF). These options are very expensive in normally $200.00 per waste ton. Under CERCLA, regulators can control or require treatment of lead wastes at almost any level as states have flexibility in setting cleanup standards. Consequently producing Pb bearing waste can be very expensive. Similar regulatory conditions exist with Japan, Swiss, etc. regulations. To date, range soils have been subject only to CERCLA action which requires stabilization or disposal of the soils at closed range sites. The soil commonly fails TCLP criteria of 5.0 ppm and is thus a characteristic hazardous waste. The current methods used to manage these lead contaminated soils are reactive, i.e., they treat the lead after the soil becomes contaminated and consequently after the hazard exists. The chemicals used to treat lead soils include phosphates, silicates, cements, and sulfides. The methods are, however, reactive in design except for Forrester 5,722,928, which suggests adding the phosphate and complexing agent to the lead bearing material or waste prior to generating waste. Even under this method, Forrester anticipated the waste already bearing Pb.

Problems to Be Solved by the Invention

The present invention preserves a method to seed range soil prior to bearing Pb, and thus the question of treating Pb at TCLP levels never manifests itself, and lead is also subject to immediate stabilization upon contact as compared to managing lead waste only after lead exposure has occurred and existed.

Means to Solve the Problems

The present invention relates to a method for reducing the leaching of lead from rifle range, handgun and shot soil berms. The method includes seeding the berm soil with dry lead stabilizing agents such that lead projectiles become mixed with lead stabilizing agents upon firing into the berm and subsequently stabilized as lead stabilizing agents apatites or compounds.

This invention has the advantage of reducing the leachability of lead immediately upon first generation as a contaminant in the soil or material berm. This allows the soil berm to remain below TCLP levels and thus exempt from RCRA hazardous waste regulation. The immediate in-situ stabilization also assures control of Pb leaching and reduction of ecological and human exposure risks by creation of immediate upon-contact water insoluble lead compounds such as pyromorphite, lead phosphates, and stable compounds with silicates, hydroxides, hydroxyapatite Pb minerals, all of which have significantly less mobility and toxicity than the projectile lead form as elemental or lead oxides.

The lead stabilizing seeds also do not modify the berm projectile adsorptive potential, density, hydraulic permeability, appearance, slope stability, fugitivity, runoff coefficients, particle size distribution, compactability or workability, and thus provides assurance that the berm will remain effective as an open environment projectile stop and recovery body. The dry stabilizing agent seed character is imperative to assure berm soils retain residual stabilizing capacity upon normal use.

Modes for Carrying out the Invention

Material or soil stabilization is herein defined as reducing the leaching of lead from beds, traps, berms, stops or barriers used in the management or control of lead projectiles at rifle, handgun, shotgun, or military ordinance ranges where such projectiles are used for target practice or competition. The reduction of leaching is determined by performing a suitable or regulatory required leaching test on the material or waste.

The lead, in the projectiles to be fired or already fired into the soil, can be in elemental form and/or cationic form. The most common form of lead is elemental in the form of projectile slugs to fine particles of slug left on soil surfaces upon contact with soil and/or other material at high velocities. The soil subjected to projectile exposure can contain as high as 100,000 ppm compositional lead and 300 ppm TCLP leachable lead. Leachable lead in lead projectile exposed soils is commonly from 50 to 100 ppm TCLP (1), 200 ppm

California Soluble Threshold Limit Concentration (STLC) and between 0.5 and 5.0 ppm total soluble and 1.0 micron suspended colloidal lead by water column and water extraction tests.

Leach test conditions, as defined herein, include the conditions to which a material or soil is subjected during dilute acetic acid leaching (TCLP), buffered citric acid leaching (STLC), distilled water or carbonated water leaching (Japan & Swiss and SW-924). Suitable acetic acid leach tests include the USEPA SW-846 Manual described Toxicity Characteristic Leaching Procedure (TCLP) and Extraction Procedure Toxicity Test (EP Tox) now used in Canada. Briefly, in a TCLP test, 100 grams of waste are stirred tumbled with 2000 ml of dilute and buffered acetic acid for 18 hours. The extract solution is made up from 5.7 ml of glacial acetic acid and 64.3 ml of 1.0 normal sodium hydroxide up to 1000 ml dilution with reagent water.

Suitable water leach tests include the Japanese leach test which tumbles 50 grams of composited soil sample in 500 ml of water held at pH 5.8 to 6.3, followed by centrifuge and 0.45 micron filtration prior to analyses. Another suitable distilled water CO_2 saturated method is the Swiss protocol using 100 grams of cemented waste at 1 cm^3 in two (2) sequential water baths of 2000 ml. The concentration of heavy metals and salts are measured for each bath and averaged together before comparison to the Swiss criteria.

Suitable citric acid leach tests include the California Waste Extraction Test (WET), which is described in Title 22, Section 66700, "Environmental Health" of the California Health & Safety Code. Briefly, in a WET test, 50 grams of waste are tumbled in a 1000 ml tumbler with 500 grams of sodium citrate solution for a period of 48 hours. Leachable lead, contained in the waste, then complexes with citrate anions to form lead citrate. The concentration of leached lead is then analyzed by Inductively-Coupled Plasma (ICP) after filtration of a 100 ml aliquot from the tumbler through a 45 micron glass bead filter. A WET result of ≥ 5 ppm lead will result in the range soil as hazardous in California state.

In one method, the range soil is contacted with a prilled stabilizing agent, which is at least slightly water soluble, dilute acetic acid soluble and/or citric acid soluble. The option of various stabilizing agents provides the design engineer flexibility in agent recipe selection, with a preferred choice responding to the site conditions as well as required leaching test criteria. The use of prilled fertilizer phosphates such as monoammonia phosphate (MAP), diammonium phosphate (DAP), Single Superphosphate (SSP), and Triple Superphosphate (TSP), would, as an example, provide a certain amount of water soluble phosphate contact with range soils immediately upon surface exposure and a higher level of soil contact and lead stabilization upon leaching from the soil and lead projectile matrix by rainwater. Depending on the desired initial dry particle contact and rainwater leaching contact, the MAP, DAP, SSP, and TSP size, dose rate, application to soil, phosphate stabilizer content, surface coating and placement method could be engineered. When lead comes into contact with the stabilizing agent either by dry surface contact or through water borne ions, it forms low water soluble compounds, typically a mineral phosphate or precipitate, which is less soluble than the lead originally in the soil or projectile, particularly under leach test conditions. For example, the mineral apatite lead phosphate $Ca_4(Pb)(PO_4)_3OH$, lead phosphate $Pb_3(PO_4)_2$, lead silicate $Pb_2(S10_3)$ and lead sulfide PbS, can be formed by adding respective precipitating agent seeds to the range soil in the presence of lead.

Examples of suitable lead precipitating and stabilizing agents include phosphates; phosphate fertilizers MAP, DAP, SSP, TSP; phosphate rock, pulverized phosphate rock, calcium orthophosphates, prilled phosphate fertilizers, dolomitic lime, pebble lime, rock lime, sulfides, metasulfides, carbonates, magnesium oxides, silicates, sodium metasilicates, cements, portland cement, phosphates, and lead complexing agent combinations and combinations of the above, phosphoric acids, green phosphoric acid, amber phosphoric acid, Coproduct solution, ortho phosphoric acid, hypophosphoric acid, metaphosphoric acid, pyrophosphoric acid, disodium hydrogen phosphate, trisodium phosphate, and combinations thereof.

The amounts of lead stabilizing agent used, according to the method of invention, depend on various factors including lead content in the soil, required lead stabilizing agent potential residual for the range soil, desired lead reduction potential and site environmental control objectives. The amount of the lead stabilizing seed to be added to the range soil to ensure adequate immobilization of lead will also depend on such variables as the alkalinity of the range soil and/or any other solid residue that may be present with a buffering capability, the amount of lead fragments initially present, and so on. It has been found that an amount of certain stabilizing agents such as prilled triple superphosphate, phosphate with complexing agents, silicates, equivalent to between about 1% and about 2% by weight of range soil is sufficient for initial TCLP stabilization and residual phosphate loading for at least 5 years of seeded range in-situ stabilization. For that matter, since an amount of the phosphate equivalent to about 2% by weight of soil worked so well, it is believed that an amount of the phosphate, phosphate with complexing agents, silicates, or other stabilizing agents source equivalent to between about 0.1% and about 2% by weight of wet soil would suffice. However, the foregoing is not intended to preclude yet higher usage of stabilizing agent seeds if needed since it has been demonstrated that amounts greater than 5% by weight also work, but are more costly.

The examples below are merely illustrative of this invention and are not intended to limit it thereby in any way.

EXAMPLE

In this example, range soil was treated with varying amounts of stabilizing seed agents including Prilled Triple Superphosphate (TSP), Granular Phosphate Rock (ROCK), Green Phosphoric Acid (PO4), Rock Lime (CAO), Rock Lime and Sodium Silicate (CAO/NS) and Coproduct (COP), and retested after various days of rainwater leaching in an open pit. The samples of seeded range soils were then extracted according to TCLP procedure set forth in Federal Register, Vol. 55, No. 126, pp. 26985-26998 (Jun. 29, 199), which is hereby incorporated by reference and water extraction by substituting deionized water for the TCLP extraction fluid solution in the TCLP test. This test procedure is also referenced in 40 C.F.R. 260 (Appendix 2) and EPA SW 846, 3rd Edition. The retained leachate was digested prior to analysis by ICP. Thereafter, reagents were added by simple hand mixing.

TABLE 1

Type-Days	Agent %	TCLP Pb(ppm)	Water Pb (ppm)
Soil-0	Baseline	143.6	1.4
Soil-0	1 TSP	15.4	ND
Soil-0	2 TSP	<0.05 (ND)	ND
Soil-0	2 PO4	ND	ND
Soil-0	2 COP	0.32	ND
Soil-0	2 ROCK	1.65	ND
Soil-0	3 CAO	0.20	1.3
Soil-0	2 CAO/1 NS	ND	ND
Soil-365	Baseline	157	0.94
Soil-365	1 TSP	4.3	ND
Soil-365	2 TSP	ND	ND
Soil-365	2 PO4	0.83	ND
Soil-365	2 COP	2.4	ND
Soil-365	2 ROCK	1.20	ND
Soil-365	3 CAO	4.2	3.2
Soil-365	2 CAO/1 NS	ND	ND

The foregoing results in Table 1 readily established the operability of the present process to immobilize leachable, TCLP and water soluble lead in the range soil while also providing various degrees of stabilizing seed within the soil thus allowing for production of a range soil which upon exposure to lead would retard lead leaching and avoid regulation as a hazardous waste due to TCLP leaching levels.. Given the effectiveness of the triple superphosphate, phosphates and complexing agents, lime, lime and silicates, in causing lead to stabilize as presented in the table 1, it is believed that an amount of the stabilizing agents such as triple superphosphate, phosphate and complexing agents, lime, lime and silicates equivalent to less than 1% by weight of range soil should be effective to immobilize lead from range projectiles. It is also apparent form the table 1 results that certain stabilizing seeds are more effective at short and long term leachate production control, such as triple superphosphate. Certain stabilizing agents have a lesser affinity to become water soluble and thus retain effective lead control at a longer period than more soluble agents such as lime. In addition certain agents have a potential to increase thje pH of the range soil and thus increase the water leaching potential of the lead as compared to baseline data. In these applications, care must be taken to assure that the control of TCLP does not cause an increase in the rainwater leaching of lead. In sites where lead water leaching is of little concern, such as a remote clay basin area, all example stabilizing agents would be suitable. In locations where leachate may be in contact with groundwater or surface water, agents should be limited to superphosphates and phosphate rock thus limiting the short-term and long-term leaching potential of lead by rainwater.

It will be apparent from foregoing that many other variations and modifications may be made in the methods and the compositions herein before described, by those having experience in this technology, without departing from the concept of the present invention. Accordingly, it should be clearly understood that the methods and compositions referred to herein in the foregoing description are illustrative only and are not intended to have any limitation on the scope of the invention.

Effects of the Invention

The seeding of soil or materials with lead stabilizing agents provides a means to stabilize lead already in the berm while also allowing for future lead bullets, fragments, or lead shot fired into the berm to be stabilized upon contact with the lead stabilizing agents seeds or contact with rainwater leaching through the lead stabilizing agents seeds. This method eliminates the need to remove and re-treat range soils, after future use.

1. Abstract

Problems

Providing a method for reducing the leaching of lead from gun and rifle range soils.

Solving Means

A method includes contacting the soil or material used as the bullet stop berm behind targets with a seeding of lead stabilizing agents.

2. Representative Drawing

None

RANGE SOIL STABILIZATION METHOD

BACKGROUND OF INVENTION

The leaching of lead into the environment has been a major concern of health officials and water supply professionals for many years. In addition to concern over direct leaching of lead into ground waters and surface waters, regulators and professionals have also been concerned with indirect leaching of lead from unlined landfills which generate acidic leaching conditions due to decay of organic matter and thus high levels of lead leaching potential. In response to the concern of lead leaching from both water and landfill leachate borne conditions, the USEPA under direction from Congress, prepared regulations for testing, managing and disposing of lead bearing wastes. The regulations under the Resource Conservation and Recovery Act (RCRA) and Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA - aka Superfund) are extensive, complex, and have great impact on industry and practices involving heavy metals including lead. Under RCRA, lead bearing wastes may be considered hazardous if failing the Toxicity Characteristic Leaching Procedure (TCLP) at 5.0 ppm, and thus required to be disposed at a hazardous waste landfill or treatment, storage and disposal facility (TSDF). These options are very expensive in normally $200.00 per waste ton. Under CERCLA, regulators can control or require treatment of lead wastes at almost any level as states have flexibility in setting cleanup standards. Consequently producing Pb bearing waste can be very expensive. Similar regulatory conditions exist with Japan, Swiss, etc. regulations. To date, range soils have been subject only to CERCLA action which requires stabilization or disposal of the soils at closed range sites. The soil

AM

commonly fails TCLP criteria of 5.0 ppm and is thus a characteristic hazardous waste. The current methods used to manage these lead contaminated soils are reactive, i.e., they treat the lead after the soil becomes contaminated and consequently after the hazard exists. The chemicals used to treat lead soils include phosphates, silicates, cements, and sulfides. The methods are, however, reactive in design except for Forrester 5,722,928, which suggests adding the phosphate and complexing agent to the lead bearing material or waste prior to generating waste. Even under this method, Forrester anticipated the waste already bearing Pb. The present invention preserves a method to seed range soil prior to bearing Pb, and thus the question of treating Pb at TCLP levels never manifests itself, and lead is also subject to immediate stabilization upon contact as compared to managing lead waste only after lead exposure has occurred and existed.

SUMMARY OF THE INVENTION

The present invention relates to a method for reducing the leaching of lead from rifle range, handgun and shot soil berms. The method includes seeding the berm soil with dry lead stabilizing agents such that lead projectiles become mixed with lead stabilizing agents upon firing into the berm and subsequently stabilized as lead stabilizing agents apatites or compounds.

This invention has the advantage of reducing the leachability of lead immediately upon first generation as a contaminant in the soil or material berm. This allows the soil berm to remain below TCLP levels and thus exempt from RCRA hazardous waste regulation. The immediate in-situ stabilization also assures control of Pb leaching and reduction of ecological and human exposure risks by creation of immediate upon-contact water insoluble lead compounds such as pyromorphite, lead phosphates, and stable compounds with silicates, hydroxides, hydroxyapatite Pb minerals, all of which have significantly less mobility and toxicity than the projectile lead form as elemental or lead oxides.

The lead stabilizing seeds also do not modify the berm projectile adsorptive potential, density, hydraulic permeability, appearance, slope stability, fugitivity, runoff coefficients, particle size distribution, compactability or workability, and thus provides assurance that the berm will remain effective as an open environment projectile stop and recovery body. The dry stabilizing agent seed character is imperative to assure berm soils retain residual stabilizing capacity upon normal use.

DETAILED DESCRIPTION OF THE INVENTION

Material or soil stabilization is herein defined as reducing the leaching of lead from beds, traps, berms, stops or barriers used in the management or control of lead projectiles at rifle, handgun, shotgun, or military ordinance ranges where such projectiles are used for target practice or competition. The reduction of leaching is determined by performing a suitable or regulatory required leaching test on the material or waste.

The lead, in the projectiles to be fired or already fired into the soil, can be in elemental form and/or cationic form. The most common form of lead is elemental in the form of projectile slugs to fine particles of slug left on soil surfaces upon contact with soil and/or other material at high velocities. The soil subjected to projectile exposure can contain as high as 100,000 ppm compositional lead and 300 ppm TCLP leachable lead. Leachable lead in lead projectile exposed soils is commonly from 50 to 100 ppm TCLP (1), 200 ppm

California Soluble Threshold Limit Concentration (STLC) and between 0.5 and 5.0 ppm total soluble and 1.0 micron suspended colloidal lead by water column and water extraction tests.

Leach test conditions, as defined herein, include the conditions to which a material or soil is subjected during dilute acetic acid leaching (TCLP), buffered citric acid leaching (STLC), distilled water or carbonated water leaching (Japan & Swiss and SW-924). Suitable acetic acid leach tests include the USEPA SW-846 Manual described Toxicity Characteristic Leaching Procedure (TCLP) and Extraction Procedure Toxicity Test (EP Tox) now used in Canada. Briefly, in a TCLP test, 100 grams of waste are stirred tumbled with 2000 ml of dilute and buffered acetic acid for 18 hours. The extract solution is made up from 5.7 ml of glacial acetic acid and 64.3 ml of 1.0 normal sodium hydroxide up to 1000 ml dilution with reagent water.

Suitable water leach tests include the Japanese leach test which tumbles 50 grams of composited soil sample in 500 ml of water held at pH 5.8 to 6.3, followed by centrifuge and 0.45 micron filtration prior to analyses. Another suitable distilled water CO_2 saturated method is the Swiss protocol using 100 grams of cemented waste at 1 cm^3 in two (2) sequential water baths of 2000 ml. The concentration of heavy metals and salts are measured for each bath and averaged together before comparison to the Swiss criteria.

Suitable citric acid leach tests include the California Waste Extraction Test (WET), which is described in Title 22, Section 66700, "Environmental Health" of the California Health & Safety Code. Briefly, in a WET test, 50 grams of waste are tumbled in a 1000 ml tumbler with 500 grams of sodium citrate solution for a period of 48 hours. Leachable lead, contained in the waste, then complexes with citrate anions to form lead citrate. The concentration of leached lead is then analyzed by Inductively-Coupled Plasma (ICP) after filtration of a 100 ml aliquot from the tumbler through a 45 micron glass bead filter. A WET result of $\geq$ 5 ppm lead will result in the range soil as hazardous in California state.

In one method, the range soil is contacted with a prilled stabilizing agent, which is at least slightly water soluble, dilute acetic acid soluble and/or citric acid soluble. The option of various stabilizing agents provides the design engineer flexibility in agent recipe selection, with a preferred choice responding to the site conditions as well as required leaching test criteria. The use of prilled fertilizer phosphates such as monoammonia phosphate (MAP), diammonium phosphate (DAP), Single Superphosphate (SSP),and Triple Superphosphate (TSP), would, as an example, provide a certain amount of water soluble phosphate contact with range soils immediately upon surface exposure and a higher level of soil contact and lead stabilization upon leaching from the soil and lead projectile matrix by rainwater. Depending on the desired initial dry particle contact and rainwater leaching contact, the MAP, DAP, SSP, and TSP size, dose rate, application to soil, phosphate stabilizer content, surface coating and placement method could be engineered. When lead comes into contact with the stabilizing agent either by dry surface contact or through water borne ions, it forms low water soluble compounds, typically a mineral phosphate or precipitate, which is less soluble than the lead originally in the soil or projectile, particularly under leach test conditions. For example, the mineral apatite lead phosphate $Ca_4(Pb)(PO_4)_3OH$, lead phosphate $Pb_3(PO_4)_2$, lead silicate $Pb_2(SIO_3)$ and lead sulfide PbS, can be formed by adding respective precipitating agent seeds to the range soil in the presence of lead.

Examples of suitable lead precipitating and stabilizing agents include phosphates; phosphate fertilizers MAP, DAP, SSP, TSP; phosphate rock, pulverized phosphate rock, calcium orthophosphates, prilled phosphate fertilizers, dolomitic lime, pebble lime, rock lime, sulfides, metasulfides, carbonates, magnesium oxides, silicates, sodium metasilicates, cements, portland cement, phosphates, and lead complexing agent combinations and combinations of the above, phosphoric acids, green phosphoric acid, amber phosphoric acid, Coproduct solution, ortho phosphoric acid, hypophosphoric acid, metaphosphoric acid, pyrophosphoric acid, disodium hydrogen phosphate, trisodium phosphate, and combinations thereof.

The amounts of lead stabilizing agent used, according to the method of invention, depend on various factors including lead content in the soil, required lead stabilizing agent potential residual for the range soil, desired lead reduction potential and site environmental control objectives. The amount of the lead stabilizing seed to be added to the range soil to ensure adequate immobilization of lead will also depend on such variables as the alkalinity of the range soil and/or any other solid residue that may be present with a buffering capability, the amount of lead fragments initially present, and so on. It has been found that an amount of certain stabilizing agents such as prilled triple superphosphate, phosphate with complexing agents, silicates, equivalent to between about 1% and about 2% by weight of range soil is sufficient for initial TCLP stabilization and residual phosphate loading for at least 5 years of seeded range in-situ stabilization. For that matter, since an amount of the phosphate equivalent to about 2% by weight of soil worked so well, it is believed that an amount of the phosphate, phosphate with complexing agents, silicates, or other stabilizing agents source equivalent to between about 0.1% and about 2% by weight of wet soil would suffice. However, the foregoing is not intended to preclude yet higher usage of stabilizing agent seeds if needed since it has been demonstrated that amounts greater than 5% by weight also work, but are more costly.

The examples below are merely illustrative of this invention and are not intended to limit it thereby in any way.

EXAMPLE

In this example, range soil was treated with varying amounts of stabilizing seed agents including Prilled Triple Superphosphate (TSP), Granular Phosphate Rock (ROCK), Green Phosphoric Acid (PO4), Rock Lime (CAO), Rock Lime and Sodium Silicate (CAO/NS) and Coproduct (COP), and retested after various days of rainwater leaching in an open pit. The samples of seeded range soils were then extracted according to TCLP procedure set forth in Federal Register, Vol. 55, No. 126, pp. 26985-26998 (Jun. 29, 199), which is hereby incorporated by reference and water extraction by substituting deionized water for the TCLP extraction fluid solution in the TCLP test. This test procedure is also referenced in 40 C.F.R. 260 (Appendix 2) and EPA SW 846, 3rd Edition. The retained leachate was digested prior to analysis by ICP. Thereafter, reagents were added by simple hand mixing.

TABLE 1

Type-Days	Agent %	TCLP Pb(ppm)	Water Pb (ppm)
Soil-0	Baseline	143.6	1.4
Soil-0	1 TSP	15.4	ND
Soil-0	2 TSP	<0.05 (ND)	ND
Soil-0	2 PO4	ND	ND
Soil-0	2 COP	0.32	ND
Soil-0	2 ROCK	1.65	ND
Soil-0	3 CAO	0.20	1.3
Soil-0	2 CAO/1 NS	ND	ND
Soil-365	Baseline	157	0.94
Soil-365	1 TSP	4.3	ND
Soil-365	2 TSP	ND	ND
Soil-365	2 PO4	0.83	ND
Soil-365	2 COP	2.4	ND
Soil-365	2 ROCK	1.20	ND
Soil-365	3 CAO	4.2	3.2
Soil-365	2 CAO/1 NS	ND	ND

The foregoing results in Table 1 readily established the operability of the present process to immobilize leachable, TCLP and water soluble lead in the range soil while also providing various degrees of stabilizing seed within the soil thus allowing for production of a range soil which upon exposure to lead would retard lead leaching and avoid regulation as a hazardous waste due to TCLP leaching levels.. Given the effectiveness of the triple superphosphate, phosphates and complexing agents, lime, lime and silicates, in causing lead to stabilize as presented in the table 1, it is believed that an amount of the stabilizing agents such as triple superphosphate, phosphate and complexing agents, lime, lime and silicates equivalent to less than 1% by weight of range soil should be effective to immobilize lead from range projectiles. It is also apparent form the table 1 results that certain stabilizing seeds are more effective at short and long term leachate production control, such as triple superphosphate. Certain stabilizing agents have a lesser affinity to become water soluble and thus retain effective lead control at a longer period than more soluble agents such as lime. In addition certain agents have a potential to increase thje pH of the range soil and thus increase the water leaching potential of the lead as compared to baseline data. In these applications, care must be taken to assure that the control of TCLP does not cause an increase in the rainwater leaching of lead. In sites where lead water leaching is of little concern, such as a remote clay basin area, all example stabilizing agents would be suitable. In locations where leachate may be in contact with groundwater or surface water, agents should be limited to superphosphates and phosphate rock thus limiting the short-term and long-term leaching potential of lead by rainwater.

It will be apparent from foregoing that many other variations and modifications may be made in the methods and the compositions herein before described, by those having experience in this technology, without departing from the concept of the present invention. Accordingly, it should be clearly understood that the methods and compositions referred to herein in the foregoing description are illustrative only and are not intended to have any limitation on the scope of the invention.

I claim:

1. A method of stabilizing lead in a range soil or material comprising contacting said range soil or material with an amount of at least one superphosphate, phosphate fertilizer, phosphoric acid, phosphate rock, phosphate and complexing agents, lime, or lime and silicates that is effective to reduce the leaching of lead from said soil or material to a level no more than 5.0 ppm lead as determined in an EPA TCLP test performed on the resulting treated soil as set forth in the Federal Register, vol. 55, no. 126, pp. 26985-26998 (Jun. 29, 1990) wherein said soil or material maintains its particulate nature suitable for use as a lead projectile collector and backstop at a rifle, handgun or ordinance firing range.

2. The method of claim 1, wherein the phosphate and phosphate and complexing agents, is selected from the group consisting of Triple Superphosphates, green phosphoric acid, phosphate fertilizers, phosphate rock, Coproduct, and salts thereof.

3. The method of claim 2, wherein the salts of phosphoric acid are alkali metal salts.

4. The method of claim 2, wherein the phosphate salt is a trisodium phosphate, disodium hydrogen phosphate, sodium dihydrogen phosphate, tripotassium phosphate, dipotassium hydrogen phosphate, potassium dihydrogen phosphate, trilithium phosphate, dilithium hydrogen phosphate, lithium dihdrogen phosphate or mixtures thereof.

5. The method of claim 2, wherein the phosphate and complexing agent as iron or aluminum are supplied as one product including Triple Superphosphate, wet process phosphoric acids, green phosphoric acid, amber phosphoric acid, or Coproduct produced from finishing aluminum.

6. The method of claim 1, wherein the range soil is contacted with at least one phosphate, phosphate fertilizer, triple superphosphate, phosphate and complexing agents, lime, lime and silicates, in an amount equivalent to 0.01% to about 15% by weight based on the total soil weight.

7. The method of claim 1, wherein the soil is contacted with at least one phosphate, phosphate fertilizer, superphosphate, phosphate rock, phosphate and complexing agent, lime, lime and silicates, in an amount equivalent to about 1.0% to about 15% by weight of total range soil.

8. The method of claim 1, wherein the soil is contacted with at least one phosphate, phosphate and complexing agent, lime, lime and silicates, in an amount equivalent to about 1 to about 5% by weight of total range soil.

9. The method of claim 1, when said contacting is performed by addition of lead contaminated or uncontaminated range soil with stabilizing agents through tilling, mixing, blending, or other forms of soil mixing.

10. A method as in claim 1 wherein the contacting step comprises contacting range soil with said at least one phosphate, phosphate and complexing agent, lime, lime and silicates, in an amount equivalent to about 1 wt% to about 15 wt% based on the total soil.

11. A method as in claim 1 wherein the contacting step comprises: applying a dry form of at least one phosphate, phosphate rock, phosphate fertilizer, superphosphate, phosphate and complexing agent, lime, lime and silicates, to said soil to form a treated soil and insolubilizing the soluble lead species in the treated soilue in-line by use of the wetting agent within the soil or in situ in a range site by contacting said soil with water to further

solubilize the phosphate, phosphate and complexing agent, lime, lime and silicates, and insolubilize the soluble lead species.

12. A method of stabilizing lead in a range soil or material comprising contacting said range soil or material with an amount of at least one lead stabilizing agent including superphosphate, phosphate fertilizer, phosphoric acid, phosphate rock, phosphate and complexing agents, lime, or lime and silicates that is effective to reduce the leaching of lead from said soil or material to acceptable leaching levels as determined in an EPA TCLP test performed on the resulting treated soil as set forth in the Federal Register, vol. 55, no. 126, pp. 26985-26998 (Jun. 29, 1990) and other leaching tests required wherein said soil or material maintains its free flowing particulate nature suitable for use as a lead projectile collector and backstop at a rifle, handgun or ordinance firing range.

13. The method of claim 12 wherein the stabilizing agent is added as a seed to the soil in a manner to both stabilize existing lead and provide residual stabilizing agent for subsequent stabilization of new lead projectiles fired into the range soil.

ABSTRACT

RANGE SOIL STABILIZATION METHOD

A method is disclosed for reducing the leaching of lead from gun and rifle range soils. The method includes contacting the soil or material used as the bullet stop berm behind targets with a seeding of lead stabilizing agents. The seeding of soil or materials with lead stabilizing agents provides a means to stabilize lead already in the berm while also allowing for future lead bullets, fragments, or lead shot fired into the berm to be stabilized upon contact with the lead stabilizing agents seeds or contact with rainwater leaching through the lead stabilizing agents seeds. This method eliminates the need to remove and re-treat range soils, after future use.

This Page is Inserted by IFW Indexing and Scanning Operations and is not part of the Official Record

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

☐ BLACK BORDERS

☐ IMAGE CUT OFF AT TOP, BOTTOM OR SIDES

☑ FADED TEXT OR DRAWING

☐ BLURRED OR ILLEGIBLE TEXT OR DRAWING

☐ SKEWED/SLANTED IMAGES

☐ COLOR OR BLACK AND WHITE PHOTOGRAPHS

☐ GRAY SCALE DOCUMENTS

☐ LINES OR MARKS ON ORIGINAL DOCUMENT

☐ REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY

☐ OTHER: ______________________________

IMAGES ARE BEST AVAILABLE COPY.
As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.